ENGINEERS AUSTRALIA

ENGINEERING HERITAGE AUSTRALIA
QUEENSLAND PANEL

HERITAGE RECOGNITION PROGRAMME

Nomination Document for

GAIRLOCH BRIDGE

INGHAM

NORTH QUEENSLAND

CONTENTS

1. Nomination Form

2. Heritage assessment

3. Assessment of Significance

4. Images and drawings

5. Interpretation Plan

6. Heritage Ceremony

7. Correspondence with the Owner

8. References

9. Acknowledgements

10. Attachments

HERITAGE AWARD NOMINATION FORM

The Administrator
Engineering Heritage Australia
Engineers Australia
Engineering House
11 National Circuit
BARTON ACT 2600

Name of work: Gairloch Bridge - nominated to be awarded an Engineering Heritage National Marker

The above-mentioned work is nominated for an award under the Heritage Recognition Program of Engineers Australia.

Location, including address and map grid reference if a fixed work: Garloch road across the Herbert River, near Ingham, North Queensland

Owner (name & address): Hinchinbrook Shire Council
25 Lannercost Street, or PO Box 366, Ingham, QLD 4850

The owner has been advised of this nomination and a letter of agreement is attached.

Access to site: Hinchinbrook Shire Council have agreed to the submission. Copy of correspondence attached.
The bridge is on a public road with a load limit restriction. Only flooding would affect access to the bridge.

Nominating Body: Engineering Heritage Australia Queensland

Andrew Barnes
Chair of Nominating Body
Date:

Chair of Divisional EHA Group
Date:

2. HERITAGE ASSESSMENT

BASIC DATA:

Item Name:	Gairloch Bridge across the Herbert River, North Queensland
Other/ Former Names:	**na**
Location:	Old Bruce Highway, Gairloch Road north of Ingham
Address:	**na**.
Suburb/ Nearest Town:	Ingham
State:	QLD
Local Govt Area:	Hinchinbrook Shire Council
Owner:	Hinchinbrook Shire Council
Current Use:	Road bridge across the Herbert River with load restrictions.
Former Uses:	Refer to 'Current Use'.
Designer:	Alfred Barton Brady
Maker/ Builder:	Contract with James Graham of South Brisbane
Year Started:	January 1890. **Year Completed:** November 1891

Physical Description:

The Gairloch Bridge (Fig 1) is a low level steel and concrete bridge. It is simple and unadorned in appearance with no posts or balustrades. The bridge comprises spans of 5.7 m in width (inclusive of kerb) by 10 m long. The total bridge length is approximately 147 m. The 14 span bridge is a submersible bridge designed to withstand inundation during major floods.

The bridge superstructure is formed with mild steel trough plates riveted together. The steel superstructure is secured to the piers and abutments with centrally placed bolts fixed in the concrete string courses. The steelwork is coated with coal tar as corrosion protection. Portland cement concrete fills the steel troughs with the roadway atop this slab edged with concrete curbing and covered with worn asphalt. At each end of the bridge, there is a pair of reflective guide posts fixed into the curb, one on each side of the road. The steel plates that make up the base of the superstructure are clearly visible on its underside (Fig 4).

Fourteen concrete pillars support the superstructure. These taper slightly from a wide base and are curved in cross-section in the direction of water flow. There is a wide raised band around the base of each pillar and a narrow band around the top. The cement that is an element of the pillars has eroded, exposing the pebbles that form part of the concrete's composition.

At the southern end of the bridge, the road passes through a deep cutting. The sides of the cutting are lined with sections of brick, stonework or loose rocks. Some of the stonework and bricks are coated with cement.

The bridge crosses the Herbert River at a point where, for most of the year, it is wide but quite shallow. Dense vegetation covers the river banks at either end of the bridge.

Physical Condition:

Gairloch Bridge is the responsibility of the Hinchinbrook Shire Council. In 2010 GHD were commissioned to assess the condition and structural integrity of the bridge[i].

A summary of the condition is outlined below and represents the current condition

1. Approaches
The approach roads are asphalt and are generally in poor condition with potholes, rutting and depressions in the road. No guardrails were present on either approach to the bridge or on the bridge edge beams.

2**. Deck Wearing Surface**
The deck wearing surface is in poor condition (Fig 2). The asphalt surface exhibits significant potholes and rutting over a large surface area. In some areas concrete overlay sections were observed which also exhibited large areas of cracking. The deck surface drainage is poor with numerous areas of ponding due to the uneven deck surface, potholes and blocked scupper holes in some areas.

Kerbing
The reinforced concrete kerbing along the outer edges of the bridge is showing minor signs of cement matrix erosion. Localised kerb areas have suffered impact damage. For the most part the kerbing is intact and in sound condition.

Steel Trough Deck
The steel trough deck is in very poor condition at the end spans at pier supports. Throughout the main spans however, the extent of corrosion does not appear to be as significant compared to the end span areas. Between spans 3-13 the existing coal tar coating appears largely intact with minimal corrosion of the decking evident in the main span area.

Piers
The mass concrete piers generally appear in sound condition.

Abutments
The mass concrete abutments appear in sound condition albeit with minor cement matrix erosion of the concrete surface (typically 10 mm depth). The wing wall on the north side of Abutment 2 appears in sound condition. The vegetation at both abutments is overgrown with silt build up also evident.

The bridge currently has a three tonne load limit.

Modifications/ Dates:

The bridge was constructed in 1890-91.
Originally the superstructure consisted of mild steel troughs filled with tarred metal (asphalt) with a roadway surface of sand. A major flood in 1894 caused considerable damage to the tarred metal necessitating its entire removal. The troughs were then filled with Portland-cement concrete which was then topped with asphalt to provide the roadway surface[ii].
Maintenance records from 2009 and historical records of the structure indicate that flood damage occurred regularly in the wet seasons which has led to wash out of the road surface, embankments and impact damage on parts of the structure[iii]

However much of the bridge contains the original structural materials utilised in the 1890s.

Historical Notes[iv]:

The Gairloch Bridge, constructed in 1890-1891, is important in demonstrating the pattern of settlement in North Queensland in the late nineteenth century. By the late 1880s, the Herbert River valley was one of Queensland's most important sugar producing areas. As the first bridge across the lower Herbert River, built to provide access to the region's port for growers on the north side of the river, the Gairloch Bridge is closely associated with the establishment of this important industry in northern Queensland.

As an early, experimental submersible bridge, the Gairloch Bridge is important in demonstrating the evolution of bridge design in Queensland and exemplifies how the colonial authorities responsible for bridge building responded to the extreme conditions of the north Queensland wet season. Submersible bridges evolved as a cost-effective solution to the problem of bridging rivers that were seasonally subject to extreme flooding, and remain common in Queensland.

As one of the state's earliest extant bridges incorporating concrete, the bridge also demonstrates the evolution of the use of concrete in bridge construction in Queensland. The Gairloch Bridge is an example of the earliest use of concrete, where it was restricted to applications requiring only compressive strength such as piers and abutments. The incorporation of concrete in the deck (in 1894) is the earliest use of concrete as a component of a deck in Australia which in effect was a form of composite construction. Previous to this concrete was first used in an arch bridge in Victoria in 1892[v].The introduction to Queensland of reinforced concrete a few years after the bridge was built broadened the applications of concrete to include components requiring tensile strength.

The designer Alfred Barton Brady presented a paper (attachment A) to the Institution of Civil Engineers (ICE) in 1896 entitled "Low Level Bridge in Queensland" which outlined the innovative approach to bridge design in Queensland at the time. It contains details on the Gairloch Bridge including sketches.

The Gairloch Bridge has been referred to in a number of respected publications and is considered by these to represent innovation and application of developing technology eg design of submersible bridges and use of Portland cement concrete. These are

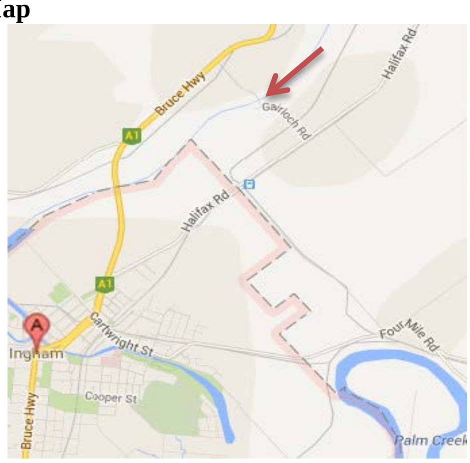
1. Two Hundred Years of Concrete in Australia[vi],
   Miles Lewis,
   Concrete Institute of Australia, 1988
2. Spanning Two Centuries, Historic Bridges of Australia[vii]
   Colin O'Connor
   University of Queensland Press, 1985
3. Early Queensland Road Bridges[viii]
   Colin O'Connor
   Main Roads Department publication Queensland Roads,
   December 1983.

Heritage Listing

The bridge has been recognized by the Queensland Heritage Register[iv] administrated by the Department of Environment and Heritage Protection

Place Name	Gairloch Bridge
Place ID	602591
Register Entry Date	17/07/2008

Locality Map



Gairloch Bridge crossing over the Herbert River

3. ASSESSMENT OF SIGNIFICANCE:

Historical Significance [iv]:
The Gairloch Bridge is a low level road bridge across the lower Herbert River near Ingham in north Queensland. Completed in November 1891, it was an innovative design by the prominent Queensland Government architect and bridge engineer, Alfred Barton Brady.

The Herbert River valley was first occupied by pastoralists in the mid-1860s. Sugarcane farming, now the dominant industry in the area, commenced during the early 1870s. By the late 1880s, the Ingham area had become one of Queensland's top sugar producers with some five mills operating in the Herbert River district.

From as early as 1885 the Hinchinbrook Divisional Board and residents of the area called for the colonial government to construct a bridge across the Herbert River to improve access for growers on the north side of the river to the region's seaport south of the river mouth at Dungeness. Unsuccessful in persuading the government to fund the construction, the board decided to raise the finance itself, and in June 1888 asked the Government Engineer for Bridges to prepare plans for the bridge.

The bridge was designed by Alfred Barton Brady, an English-born civil engineer and architect who migrated to Australia in 1884. From 1885 he held a position as Assistant Engineer for Bridges with the Railways Department in Queensland before being appointed Acting Engineer for Bridges in the Department of Mines and Works in June 1889. In the Department of Mines and Works and its successor departments, Brady had a distinguished career rising to the position of Government Architect and Engineer of Bridges in 1892 and Undersecretary in 1901. He held this position until his retirement in 1922.

The contract for construction of the bridge was awarded to James Graham of South Brisbane who commenced work early in 1890. Following a number of delays, partly caused by the frequent flooding of the river, the bridge was completed at a cost of £7,737 and opened for traffic on 4 November 1891.

The Gairloch Bridge was the first road bridge designed by Brady as Engineer for Bridges in the Department of Mines and Works. Other bridges designed by him included the Burnett River Bridge at Bundaberg, Victoria Bridge in Brisbane (no longer extant), and the Lamington Bridge in Maryborough (1896, QHR 600721). The Lamington Bridge was a Wunsch-system structure of reinforced concrete, the first such design in Australia.

The bridge at Gairloch, which pre-dates the Lamington Bridge by five years, demonstrates one of the earliest uses of concrete in bridge construction in Queensland. Prior to the introduction of reinforced concrete to Australia in the 1890s, concrete as a component of bridges took the form of un-reinforced abutments, piers and mass concrete culverts, the earliest known being railway culverts constructed in South Australia in 1878. In 1882, concrete culverts were used on the Warwick to Stanthorpe railway line in Queensland. The original bridge across the railway in Edward Street, Brisbane, designed by FDG Stanley in 1887 had concrete abutments. The concrete piers and abutments of the Gairloch Bridge, designed in 1889, are among the earliest known in Queensland. From c1890, the greater availability of locally made Portland cement made the use of this material in bridge construction much more common.

Against the expectations of its designer, the bridge did not perform well initially. On 11 June 1892, the Queenslander reported that it required 'rather a large amount of money to keep it in repair'. A major flood in 1894 resulted in two sections of iron troughing being lifted and doubled over by the force of the flood. This necessitated the complete renewal of the roadway with layers of concrete and tarred metal. Then, in 1927, a record flood completely destroyed the northern approach to the bridge. In 1929, the bridge roadway was resurfaced and the hardwood curbing was replaced with concrete.

The inconvenience incurred by the periodic inundation of the bridge eventually prompted the construction of two high-level bridges across the lower Herbert River: one linking Halifax with Macknade and Ripple Creek in 1927; and in the late 1960s another was built upstream from the Gairloch Bridge. Despite its early set-backs, the

1891 low-level bridge has survived in the long-term and this has been attributed to its innovative design, which presents a small obstruction to flood flow. The bridge continues to be used.

Historic Association:

The Gairloch Bridge is important in demonstrating the principal characteristics of submersible bridges: it is a low level bridge, crossing only the main channel of the river, and is designed to present the least possible obstruction to flood waters and debris.

The bridge is also important as the earliest known example in Queensland of a road bridge designed by the notable architect and engineer, AB Brady. The bridge was designed soon after his appointment as Engineer of Bridges in the Department of Mines and Works. Other important bridges designed by Brady include the third Victoria Bridge in Brisbane (no longer extant) and the Lamington Bridge in Maryborough (1896, QHR 600721).

Creative or Technical Achievement:

The Gairloch Bridge is a submersible bridge designed to withstand inundation during major floods. It is the first submersible road bridge known to have been designed by Brady who is recognised for his important contributions to the development of this type of bridge. The shorter, submersible bridges were a cost-effective alternative to designing longer bridges above major flood levels, which often inundated a considerable area either side of the river. The principal difficulty of submersible bridges was that debris accumulated against the bridge during floods and this, in combination with the force exerted by the water, could cause major damage. Brady developed designs to avoid trapping debris and to present the least possible obstruction to the flow of flood waters. To date, it remains common practise to design less important bridges to withstand flood submergence.

The Gairloch Bridge incorporated a number of features that were innovative at the time. For the decking, Brady used 33 foot (10m) lengths of mild steel trough plate, 12 inches (30cm) deep, riveted together and securely bolted down to the concrete string-courses. The troughs were the structural component of the deck spanning longitudinally between the concrete piers. This is the first known use of such a system in Australia. The troughs were then filled with tarred metal. The curbs and posts were of hardwood. Brady argued that this design had important advantages in flood conditions due to its greater weight and because the steel troughs eliminated the need for girders, the bridge offered less resistance to the flow of flood waters. This design option was more costly than a bridge using the more conventional timber decking and superstructure, but Brady argued that the maintenance cost of his design would be less. The Gairloch Bridge is the only known road bridge of this design in Australia.

The design is also innovative for its early use of Portland cement concrete in the piers, abutments and string courses. In 1894 Portland cement concrete replaced the original asphalt filling of the steel troughs providing improved resistance to degradation under flooding. This use of concrete as an integral part of the deck represented an early form of composite construction which is the earliest type of this form of construction in Australia.

Research Potential:

The Hinchinbrook Shire Council is currently considering the future of the Gairloch Bridge. GHD have prepared a report[ix] into the decommissioning of the bridge as a trafficable structure and to also meet obligations under the Queensland Heritage Act.

Social:

The Gairloch Bridge, constructed in 1890-1891, is important in demonstrating the pattern of settlement in North Queensland in the late nineteenth century. By the late 1880s, the Herbert River valley was one of Queensland's most important sugar producing areas. As the first bridge across the lower Herbert River, built to provide access to the region's port for growers on the north side of the river, the Gairloch Bridge is closely associated with the establishment of this important industry in northern Queensland. The bridge was also innovative for its time in

providing a cost effective structure to address the challenges of seasonal flooding of major rivers in North Queensland

Rarity/Representativeness:
The Gairloch Bridge is the only known road bridge of this design in Australia.

It was a pioneer in the early use of Portland cement concrete in both the substructure and the deck.

The design of the deck was innovative utilizing mild steel troughs as the main structural element between piers thus minimizing the profile exposed to floodwaters. The use of concrete in the deck represented an early form of composite concrete steel deck which would make it the oldest such bridge in Australia.

Integrity/ Intactness:
The bridge remains in use today with a three tonne load restriction.

Statement of Significance:

The Gairloch Bridge is a low level road bridge across the lower Herbert River near Ingham in north Queensland. Completed in November 1891, it was an innovative design by the prominent Queensland Government architect and bridge engineer, Alfred Barton Brady. As an early, experimental submersible bridge, the Gairloch Bridge is important in demonstrating the evolution of bridge design in Queensland and exemplifies how the colonial authorities responsible for bridge building responded to the extreme conditions of the north Queensland wet season

The superstructure was innovative for its time. It is the first known submersible bridge in Australia that utilized mild steel troughs imported from England as the structural element between piers. As Brady refers in his paper[ii]
"The trough form of superstructure possesses many advantages for short spans, as girders may be entirely dispensed with, and, in the case of low-level bridges, the small depth of the troughs offers but little resistance to the passage of floodwaters during the wet seasons".

The design is also innovative for its early use of Portland cement concrete in the piers, abutments and string courses. In 1894 Portland cement concrete replaced the original asphalt filling of the steel troughs providing improved resistance to degradation under flooding. This use of concrete as an integral part of the deck represented an early form of composite construction which is the earliest type of this form of construction in Australia.

The bridge was designed by Alfred Barton Brady, an English-born civil engineer and architect who migrated to Australia in 1884. From 1885 he held a position as Assistant Engineer for Bridges with the Railways Department in Queensland before being appointed Acting Engineer for Bridges in the Department of Mines and Works in June 1889. In the Department of Mines and Works and its successor departments, Brady had a distinguished career rising to the position of Government Architect and Engineer of Bridges in 1892 and Undersecretary in 1901. He held this position until his retirement in 1922.

Area of Significance

This proposal seeks a listing for a Engineering Heritage National Marker.

4. IMAGES and DRAWINGS

Fig 1 Gairloch Bridge from downstream

Fig 2 Gairloch Bridge Roadway Surface

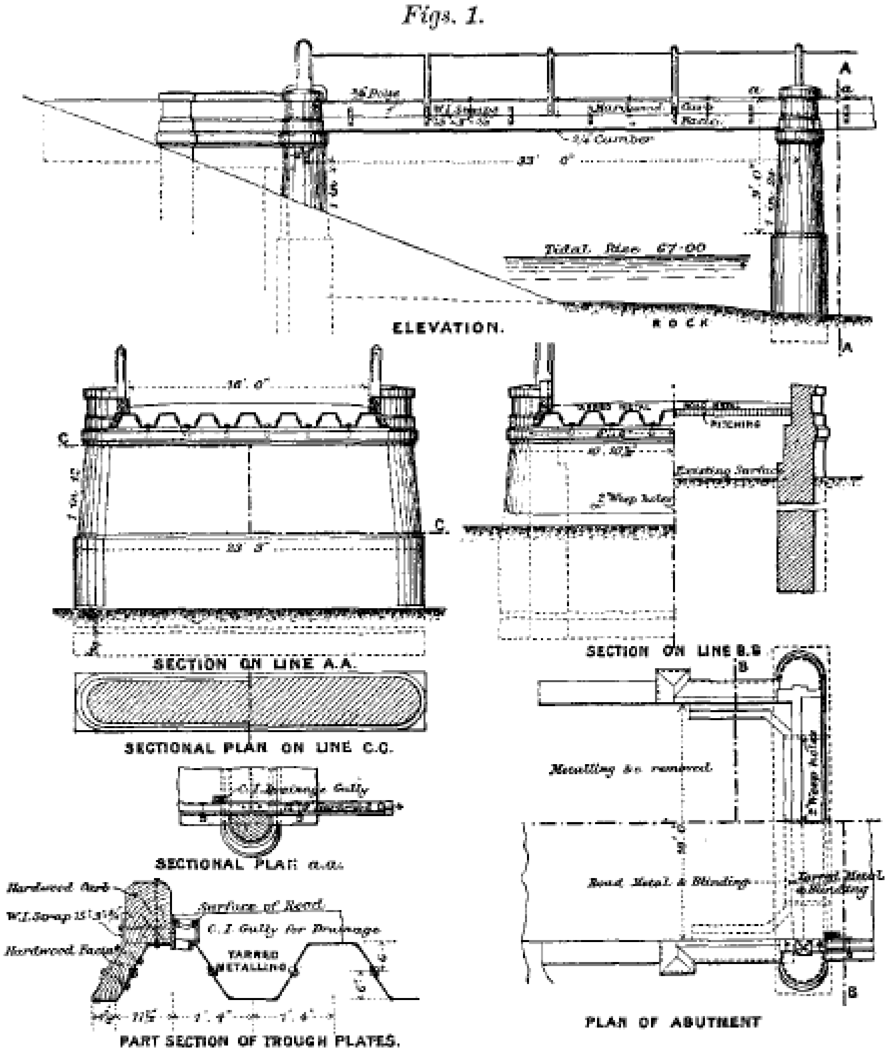
Fig 3 Gairloch Bridge Deck and Piers

Fig 4 General view of Gairloch Bridge Deck Soffit

Fig 5 Gairloch Bridge 1900

Fig 6 Gairloch Bridge Deck early 1900s

Fig 5 Extract from Bradys Paper "Low-Level Bridges in Queensland" 1896



Scale, $\frac{1}{16}$ inch to 1 foot.

HERBERT RIVER BRIDGE, GAIRLOCH.

5. INTERPRETATION PLAN

The Interpretation Panel will be designed later in the year and submitted for approval to the committee.

Content would include

- History of the area
- Design concepts of the submersible bridge
- Extracts from Bradys Paper including sketches.
- Information on Brady and his career

6. HERITAGE CEREMONY

It is a proposed to have the ceremony on site in March 2014

7. CORRESPONDENCE WITH THE OWNER

Copy of correspondence with Hinchinbrook Shire Council is attached (Attachment B1 and B2)

8. REFERENCES

[i] GHD Report - Hinchinbrook Shire Council, Condition & Structural Assessments Bridges, Gairloch Bridge, Gairloch Road, Ingham, August 2010,

[ii] Brady, A.B. "Low Level Bridges in Queensland", *ICE Minutes of Proceedings* 124 (1896):Paper 2880 pp323-326. See Attachment A

[iii] GHD Report - Hinchinbrook Shire Council, Condition & Structural Assessments Bridges, Gairloch Bridge, Gairloch Road, Ingham, August 2010, page 3

[iv] Department of Environment and Heritage Protection, Queensland Heritage Register, Gairloch Bridge
https://heritage-register.ehp.qld.gov.au/placeDetail.html?siteId=3944

[v] Spanning Two Centuries, Historic Bridges of Australia, Colin O'Connor, University of Queensland Press, 1985, page 116
http://www.textqueensland.com.au/item/book/c5ce24e24be2e39b0d762174723610d2

[vi] Two Hundred Years of Concrete in Australia, Miles Lewis, Concrete Institute of Australia, 1988

[vii] Spanning Two Centuries, Historic Bridges of Australia, Colin O'Connor, University of Queensland Press, 1985
http://www.textqueensland.com.au/item/book/c5ce24e24be2e39b0d762174723610d2

[viii] Early Oueensland Road Bridges, Colin O'Connor, Main Roads Department publication Queensland Roads, December 1983.

[ix] GHD Report - Hinchinbrook Shire Council, Gairloch Bridge, Decommissioning Plan, August 2010

9 ACKNOWLEDGEMENTS

This submission would like to acknowledge the support of the following people

- Colin O'Connor for his excellent reference material and advice
- Andrew Barnes Chairperson of the Queensland EA Heritage Committee
- Judith Nissen Historian
- Colin Gray Hinchinbrook Shire Council
- Dr Ross Pritchard Bridge Engineer Queensland Transport and Main Roads

10 ATTACHMENTS

A Brady, A.B. "Low Level Bridges in Queensland", ***ICE Minutes of Proceedings*** **124 (1896):Paper 2880 pp323-326.**

B Hinchinbrook Shire Council Correspondence

10. Attachments - A Brady, A.B. "Low Level Bridges in Queensland", ICE minutes of Proceedings 124 (1896):Paper 2880 pp323-326.

(*Paper No. 2880.*)

"Low-Level Bridges in Queensland."

By ALFRED BARTON BRADY, M. Inst. C.E.

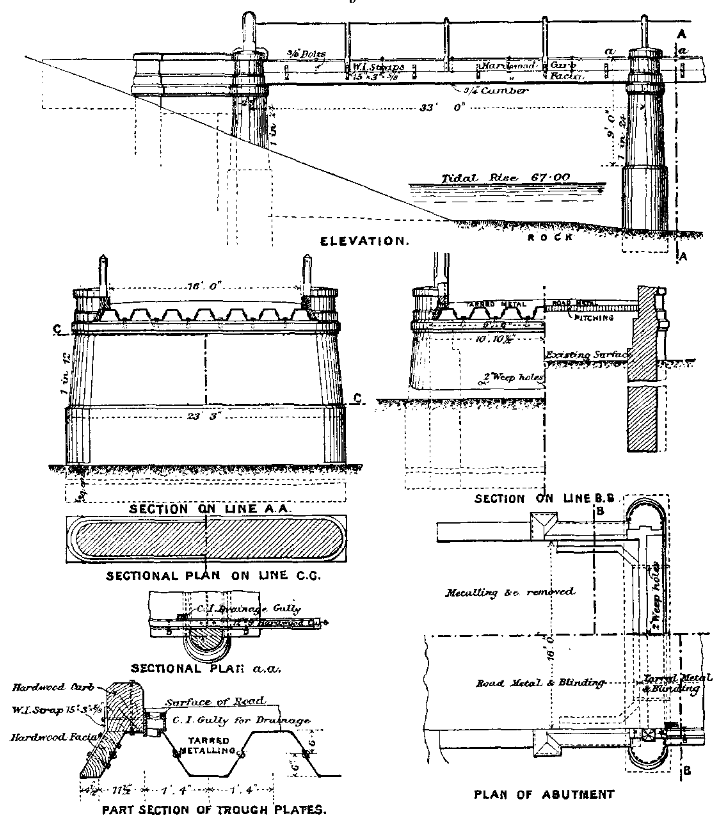
IN Queensland and in other parts of Australia where heavy floods are frequent, low-level bridges are necessary for carrying the main stock-routes and roads for mail-coaches, carriers' teams, cattle and sheep over the rivers and creeks in the interior. High-level bridges, above the reach of all floods, would be too costly; and even if constructed would in many instances be unapproachable during the wet seasons, on account of the low-lying country on each side being submerged. Low-level bridges are found to be much less liable to be carried away by floods than semi-high-level structures; and are frequently built even where the higher bridge would, on account of being near to centres of population, be more desirable. Floating logs and driftwood cannot accumulate against a low-level bridge, for débris is not usually carried down-stream in considerable quantity until the bridge is entirely submerged, and then all trees, logs and rubbish can float harmlessly over it. A high-level bridge to be perfectly safe, must be above the level of the highest possible flood, and must admit of the free passage of logs underneath the superstructure. In some instances, during the floods of January, 1887, March, 1890, and February, 1893, high-level bridges have been destroyed, through no defect in the design or fault in construction, but solely on account of the water reaching such a height that the superstructure was subjected to great lateral pressure from the accumulated drift, to resist which they had not been designed. Bridges built at a low level must, however, be of strong and in some localities of exceptional construction, to successfully resist the repeated strains to which they are subjected every year during the flood-season.

The four bridges to be described are typical examples of low-level bridges which have recently been erected in Queensland.

HERBERT RIVER BRIDGE, GAIRLOCH.

The level of the decking of this bridge, *Figs. 1*, is 10 feet above high water of ordinary spring-tide, or 29 feet below the highest flood-mark. The bridge has a total length over the abutments

Figs. 1.



Scale, $\frac{1}{16}$ inch to 1 foot.

HERBERT RIVER BRIDGE, GAIRLOCH.

of 481 feet 3 inches; and consists of fourteen spans of 33 feet each, the clear width of roadway between the curbs being 16 feet.

Piers and Abutments.—The piers, thirteen in number, together with the abutments and wing-walls, are built of Portland-cement concrete composed of one part of cement, three parts of clean

sharp river-sand, and six parts of hardstone broken to 2-inch gauge. The string-courses under the steel superstructure were formed of a stronger concrete composed of one part of cement, two parts of sand, and three parts of hardstone broken to $1\frac{1}{2}$-inch gauge. The pier foundations were laid on rock at depths varying between 4 feet 6 inches and 6 feet below high water, temporary wrought-iron caissons, constructed in sections bolted together, having been used. The maximum depth of sand overlying the rock-bottom was 4 feet 6 inches; and the maximum depth of sinking in the rock 1 foot 6 inches. Each pier has semicircular ends with a batter of 1 in 12 above the plinths; the batter of the sides, between the splayed plinth and the underside of string-course, being 1 in 24. All exposed faces of the concrete in the piers and abutments were floated with a mixture of one part of Portland cement to two parts of sand.

Superstructure.—The superstructure or decking of the bridge was formed of mild-steel trough-plates 12 inches in depth, weighing 25·82 lbs. per square foot of area covered. The plates were cambered to the extent of $\frac{3}{4}$ inch at the centre of each span, and the sections riveted together with $\frac{5}{8}$-inch rivets at 6-inch pitch throughout. The trough form of superstructure possesses many advantages for short spans, as girders may be entirely dispensed with, and, in the case of low-level bridges, the small depth of the troughs offers but little resistance to the passage of flood-waters during the wet seasons. The whole of the steel-work received three coats of tar. For securing the steel superstructure to the piers and abutments, 1-inch lewis-bolts were fixed in the concrete string-courses, the upper surfaces of which were trowelled smooth and level, to form a uniform bearing for the steel-trough decking. The bolt-holes at one end of each trough were slotted to allow for expansion of the decking.

Roadway.—The road- or carriage-way was formed of metalling broken to 2-inch and 1-inch gauges in equal proportions, mixed with boiling coal-tar. The troughs were completely filled with tarred metal, and were covered to a depth of 7 inches at the crown and 5 inches at the curbs, being well punned and afterwards rolled and covered with sand. Drainage from the surface of the roadway is provided for by thirty gullies having outlets through holes cut in the trough decking. The curbs are of Moreton Bay ash, 12 inches by 9 inches, bolted to the steel decking; and the hand-railing is of hard-wood posts and iron chains easily removable.

Approaches.—The approaches were made in cutting through the sandy formation of the banks, the cutting for the south approach

10. Attachments - A Brady, A.B. "Low Level Bridges in Queensland", ICE minutes of Proceedings 124 (1896):Paper 2880 pp323-326.

having a maximum depth of 17 feet. The slopes were faced with bricks laid in cement; and concrete water-tables were constructed at the foot of the slopes.

Flood Tests and Repairs.—During the construction of this bridge exceptionally bad weather was experienced; and two of the highest floods known in the locality occurred, resulting in considerable delays, loss of plant and materials, and damage to the approaches. In April, 1894, two and a half years after the bridge was opened for traffic, the Herbert river was visited by the most disastrous flood that has ever been recorded in the district, considerable damage occurring to the tarred metal or asphalt roadway on the bridge, necessitating its entire renewal. In repairing the roadway the quantity of tarred metalling, which, on account of its depth in the troughs of the decking, required a long time to set sufficiently hard for traffic, was reduced by filling the troughs to a depth of 12 inches, and forming a surface over the decking, with Portland-cement concrete, upon which tarred metalling or asphalt was laid to a depth of 6 inches, and reduced by rolling to 5 inches. The concrete was composed of one part of Portland-cement, one part of river sand, and six parts of stones from the river, of 2-inch, 1-inch, and $\frac{1}{4}$-inch gauges in equal quantities. The asphalt was formed of broken river-metal of 2-inch and 1-inch gauges in equal quantities, mixed with $\frac{1}{4}$-inch screened river-gravel, in the ratio of six parts of stone to one of screened gravel. After being thoroughly dried, heated, and well mixed with the required quantity of boiling coal-tar, it was stacked to allow the superfluous tar to drain off, and then laid on the surface of the concrete and rammed and rolled. The surface was finished with 1 inch of tarred sand and screenings, composed of four parts of coarse sand and two parts of fine gravel, screened, dried, heated and mixed with boiling coal-tar as before. After finishing, the entire surface was covered with clean sharp river-sand to a depth of $\frac{1}{2}$ inch; and, to give sufficient time for the asphalt to harden, a month was allowed to elapse before the bridge was re-opened for traffic.

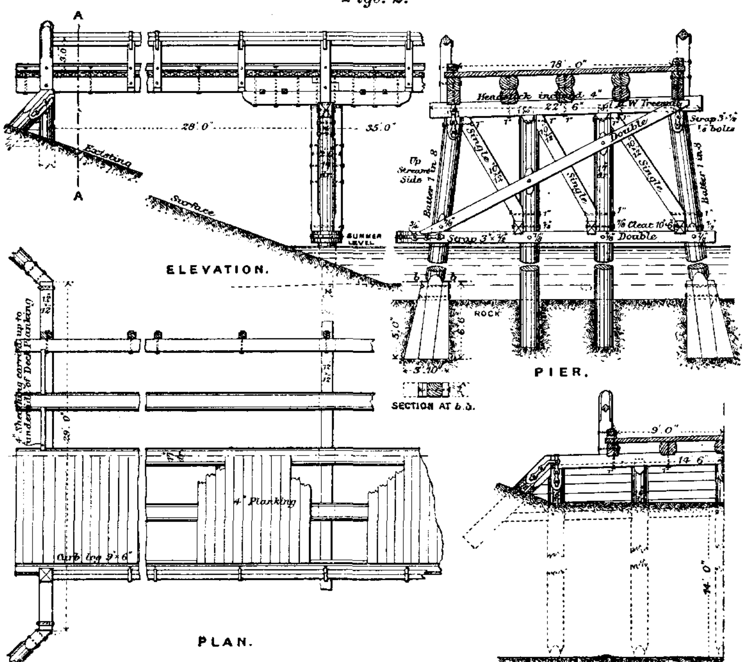
Cost.—The contract for the construction of this bridge was let in January, 1890, and it was completed and opened for traffic on the 4th of November, 1891, the total cost of the bridge and approaches amounting to £7,737 16*s.* 7*d.* The cost of the bridge, exclusive of approaches, amounted to £5,704 4*s.* 0*d.*, or £11 17*s.* 0*d.* per lineal foot. The cost of the concrete and asphalt work, together with some other necessary repairs, amounted to £684; the total cost of the bridge being thus increased to £13 3*s.* 6*d.* per lineal foot.

10. Attachments - A Brady, A.B. "Low Level Bridges in Queensland", ICE minutes of Proceedings 124 (1896):Paper 2880 pp323-326.

BALONNE RIVER BRIDGE, ST. GEORGE.

This bridge, *Figs.* 2, is wholly of bloodwood (*Eucalyptus corymbosa*), and consists of twelve spans of 35 feet each, with two end-spans of 28 feet each; the total length over the decking being 481 feet, and the width of roadway between the curbs, 18 feet. The height of the bridge above the lowest or dry-weather level of the river is 15 feet, the highest flood having reached a level of 16 feet

Figs. 2.



Scale, $\frac{1}{16}$ inch to 1 foot.

BALONNE RIVER BRIDGE.

above the bridge decking. The bed of the river consists entirely of hard rock.

Piers.—Each pier has four piles spaced at 6-foot 2-inch centres at the level of the headstock; the two outer piles having a batter of 1 in 8, and the two intermediate piles being planted vertically. The diameter of the piles, exclusive of sapwood, is 17 inches, the butt-end being placed downwards in every case. Each of the

outer or battered piles was lewised to the rock-bed of the river, each hole being cut to a depth of 5 feet, the dimensions at the bottom being 46 inches long by 14 inches wide. The sides and one end were cut vertically, and the opposite end tapered so as to reduce the length of the hole at the surface to 26 inches. The sides and ends of each hole were carefully rough-tooled to exact lines; and properly-shaped wedges of seasoned bloodwood were then inserted, and made to bear evenly against the rock. The feet of the piles were squared for a length of 6 feet 6 inches; they were then inserted in position between the wedges, and firmly driven home; the whole being securely bolted together above the surface of the rock. The wedges and the feet of the piles before being fixed were twice coated with Stockholm tar; and, after fixing, the interstices were completely filled in with strong-cement grout. The two intermediate piles in each pier, and also the abutment piles, were planted in rock, the holes for which, 24 inches in diameter, were jumped or excavated to a depth of 4 feet. The feet of the piles were freed from sapwood, and twice coated with Stockholm tar; they were then planted in the rock, the space round each pile being completely filled with cement concrete. The sites of eight of the twelve piers were above the summer level of the river, but the first four piers from the St. George side of the river were in water, necessitating the provision of a cofferdam for each pier, to admit of the holes in the rock being cut without the aid of divers. Each pier was capped with a 12-inch by 12-inch headstock inclined 4 inches in its length towards the upstream side of the bridge, and provided with double 10-inch by 6-inch walings above water- or rock-level, three 10-inch by 12-inch struts between the piles, and double 10-inch by 6-inch diagonal braces. The waling and braces were cogged on to the piles, and the whole well bolted together. The upstream ends of each pair of walings were shaped and blocked solid to form a cutwater, and were well secured with wrought-iron straps and bolts.

Superstructure.—Each span consists of five girders or stringers scarf-jointed over the piers, and carried upon single corbels, 14 feet long, through which the girders were bolted. The corbels were cogged on to the pier headstocks; and, in addition to being bolted, the girders were keyed to the corbels with well-seasoned wedge-keys tightly driven, working 3 inches square, and having a 4-inch projection on each side for tightening. The superstructure is secured to the piers by through-bolts and anchor-bolts. The decking consists of 9-inch by 4-inch planks laid

transversely over the girders in one length from side to side, and spiked down with 8-inch by ½-inch spikes. The outer girders and corbels exposed to view are of hewn timber 14 inches by 12 inches; the inner girders and corbels being of round timber 17 inches in diameter, exclusive of sapwood, adzed flat to a thickness of 14 inches over all bearings and for the planks of the decking. The entire superstructure is built with an inclination of 4 inches towards the upstream side to prevent lodgment of driftwood under the bridge decking in time of flood. The abutments were sheathed at the back of the piles with 4-inch planking, carried also along the wings of the abutments. The curbs measure 9 inches by 6 inches, and are rounded on one edge and bolted through the decking and girders; the curb on the upstream or lower side of the bridge being raised 1½ inch to allow for drainage from the surface of the decking. The handrails, 6 inches square, are placed diagonally on 9-inch by 6-inch intermediate posts, and 9-inch by 9-inch main posts over the piers, terminating at the ends of the bridge in 12-inch by 12-inch guard-posts securely fixed to the girders of the end spans and tenoned into the abutment headstocks. The handrailing is only 3 feet above the decking, and of exceptional strength, without intermediate rails and wires, so as to offer as little resistance as possible during floods, and to enable it to withstand the pressure due to the accumulation of flood débris. Strong permanent handrails are to be preferred to movable handrails, which are troublesome and expensive, and their removal at the vital moment is often neglected.

Painting and Tarring.—The whole of the timber-work received three coats of oxide paint, with the exception of the decking, which was covered with three coats of Stockholm tar.

Flood Tests.—Since it was opened for traffic, this bridge has been several times submerged by floods without sustaining injury.

Cost.—The construction of the bridge was commenced in October, 1890, and it was opened for traffic in June, 1892, after many troublesome delays in consequence of wet weather and floods. The total cost amounted to £4,467 16*s.* 4*d.*, inclusive of approaches, which alone cost £419 10*s.* 0*d.*, the cost of the bridge per lineal foot amounting to £8 8*s.* 4*d.*

Mary River Bridge, Tiaro.

This bridge was built to replace that washed away by floods in July, 1889. Its total length is 306 feet, and it consists of seven 35-foot spans and two 28-foot end-spans; the entire work, with the

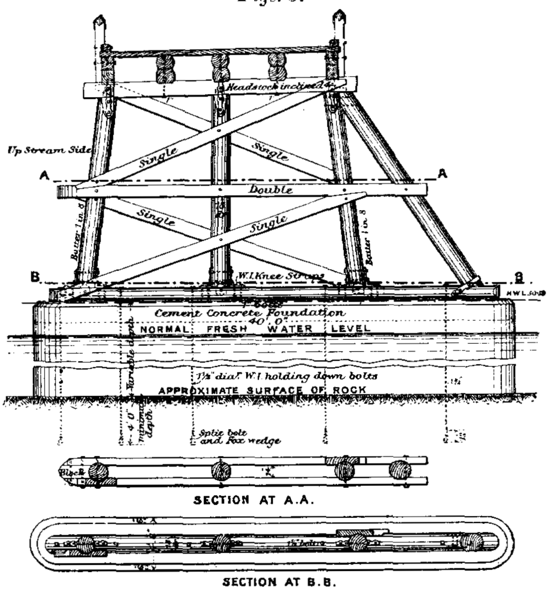
exception of the pier foundations, having been constructed of Queensland grey ironbark.

Foundations.—The concrete work in the foundations for the piers was built within timber framing sheeted down to the rock-level. The bottom was sealed with a layer of concrete, after which the water was pumped out and the concreting completed in layers 12 inches thick well rammed. The concrete was composed of six parts of broken stone, of 2-inch gauge, three parts of river-sand and one part of Portland-cement. Each foundation is 40 feet in length and 4 feet 6 inches in breadth, and is built to a level of 3 inches above high water.

Piers.—Each pier consists of three piles 18 inches in diameter, free from sapwood, spaced 9 feet 3 inches from centre to centre at the headstock level, and placed with the butt end downwards. The centre pile is vertical and the two outer piles have a batter of 1 in 8. A strut, 18 inches in diameter, is provided on the downstream side of each pier with a batter of 1 in $1\frac{1}{2}$ to further increase the base and to assist in resisting the overturning tendency during floods. The piles and struts are tenoned into the headstocks and sills, and secured to the latter by wrought-iron knee-straps and bolts. The sills are 37 feet 6 inches long and 18 inches in diameter, squared on the top and bottom to a depth of 12 inches, and bedded in cement. They are secured by five wrought-iron anchor or holding-down bolts passing through the concrete foundations, and to a depth of 4 feet into the solid rock, where each bolt is fox-wedged. Holes for the bolts were drilled in the rock to the required depth, through 4-inch tubes driven through the sand where it overlay the rock. Wrought-iron bolts $1\frac{1}{2}$ inch in diameter, with the lower end of each split for a length of 12 inches, and having wrought-iron fox-wedges inserted, were then put in place and firmly driven so as to fill each hole tightly at the bottom. The tubes were left in position and afterwards completely filled with strong cement grout. The bolts were increased to 2 inches in diameter at the screwed end, and over the sills they were provided with strong cast-iron washers and double nuts. The bolts vary in length between 9 feet 6 inches and 13 feet; and they are spaced at intervals of 5 feet, 6 feet, 11 feet and 10 feet respectively in each pier foundation, three being on the upstream side of the central pile, and two on the downstream side, *Fig. 3*, the greater lifting or overturning force being exerted at the upstream end of each pier when the floods reach the level of the underside of the superstructure. After the bridge has become completely submerged, its liability to injury

from flood-pressure or floating logs and débris ceases, until the water during subsidence reaches the level of the decking, when this element of danger to the structure again manifests itself. Each head-stock to the piers is of 14-inch by 14-inch squared timber and 22 feet 6 inches in length, inclined 4 inches from the downstream to the upstream pile to give the required inclination to the superstructure. Each pier is well braced and stiffened with 12-inch by 6-inch walings and braces cogged and bolted to the piles, the upstream end of each pair of walings being filled solid

Figs. 3.



Scale, $\frac{1}{16}$ inch to 1 foot.

PIER OF MARY RIVER BRIDGE, TIARO.

and rounded to form a cut-water and prevent floating driftwood being caught between the walings.

Superstructure.—The decking of the bridge is at a level of 21 feet above high water, and 31 feet below the level of the highest known flood; the width of the roadway between the curbs is 18 feet. The design of the superstructure and abutments is similar to that of the Balonne river bridge at St. George, *Figs.* 2, the decking and girders being inclined or canted over in an upstream direction to the extent of 4 inches.

Flood Tests.—This bridge has been severely tested since its erection, several floods having passed over it, that of February,

10. Attachments - A Brady, A.B. "Low Level Bridges in Queensland", ICE minutes of Proceedings 124 (1896):Paper 2880 pp323-326.

1893, being the highest and most disastrous on record in the valley of the Mary, but no injury was sustained by the structure.

Cost.—The contract for the bridge was signed on the 9th September, 1890, and, with approaches, completed and opened for traffic on the 23rd of February, 1891; the total cost, exclusive of supervision, amounted to £2,913 3*s.* 2*d.*, the cost of the bridge, exclusive of approaches, being £9 5*s.* 2*d.* per lineal foot.

Mary River Bridge, Gympie.

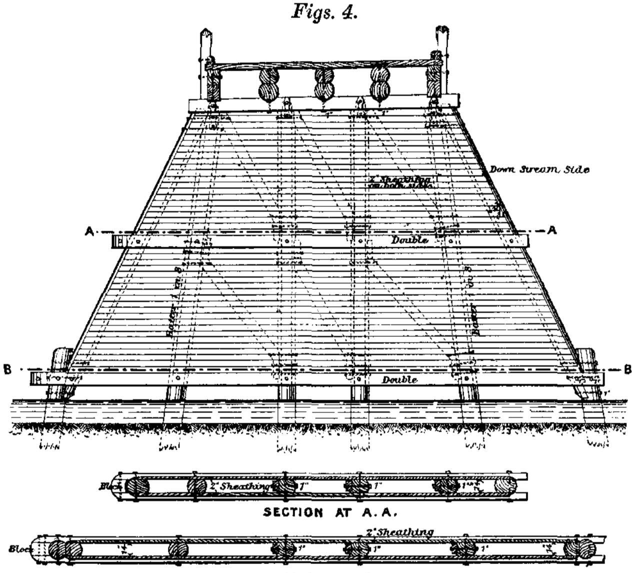
The old Channon Street bridge over the Mary River at Gympie was destroyed by heavy floods in July, 1892. Plans were prepared towards the end of that year for a timber bridge to be erected on the original site and at the same height as the old structure, 28½ feet above the summer-level of the river, or about 45 feet below the highest known flood-level. Tenders were invited for the work in January, 1893, and a contract let early in March. There are seven spans, one 40 feet, two 38 feet, two 30 feet, and two 20 feet long; the total length of the decking is 221 feet, and the width of roadway between the curbs 18 feet. The bridge is built of ironbark, blue gum, and spotted gum; and in design the superstructure is similar—excepting as to length of spans—to the St. George and Tiaro Bridges.

Piers.—The piers are of a design not previously adopted in low-level timber bridges, the piles being close sheathed on both sides of the pier with planking, *Figs.* 4, to prevent floating logs, branches of trees, and other débris becoming locked or entangled in the bracings during floods, and thereby endangering the safety of the bridge. This new feature in timber bridge-piers has since been adopted in several other bridges, and has given satisfactory results. Each pier of the Gympie bridge consists of four main or bearing piles and two strut piles, 18 inches in diameter at the head and 12 inches in diameter at the toe, and driven to a hard foundation. The outer main piles have a batter of 1 in 8, the two intermediate piles being vertical; whilst the two struts, from the headstock to the strut piles, have a batter of 1 in 2, the pier-base being 46 feet. The piles were driven to an average depth of 21 feet, with a 25-cwt. monkey falling 8 feet, each pile being shod with a wrought-iron shoe weighing 28 lbs. The headstocks of the piers are 12 inches square and 22 feet 6 inches long, and are inclined 4 inches in their length in an upstream direction. The walings are double 12-inch by 6-inch timbers, and are cogged and bolted to the piles, the usual diagonal bracings being omitted; but diagonal struts 12 inches by 10 inches between the piles are substituted, each

10. Attachments - A Brady, A.B. "Low Level Bridges in Queensland", ICE minutes of Proceedings 124 (1896):Paper 2880 pp323-326.

strut being bolted at each end to the piles, and abut upon chocks or cleats checked on to the walings and bolted to the piles. All the piles are squared or adzed to a thickness of 12 inches above the level of the bottom walings to receive the plank sheathing. The sheathing consists of 6-inch by 2-inch hard-wood planking, laid parallel to the walings in long lengths flush and close, and secured to the piles and squared struts with three $\frac{3}{8}$-inch spikes 5 inches long. The whole of the timberwork in the piers of this bridge was coated three times with Stockholm tar, and the superstructure

Figs. 4.



Scale, $\frac{1}{16}$ inch to 1 foot.

PIER OF MARY RIVER BRIDGE, GYMPIE.

received three coats of red-oxide paint. These are found to be the best preservatives for timber in the climate of Queensland.

Cost.—The bridge was opened for traffic on the 11th October, 1893, the total cost, inclusive of approaches, amounting to £1,500 8*s.* 6*d.*, the cost of the bridge alone being £1,443 3*s.* 6*d.*, or equal to £6 11*s.* 6*d.* per lineal foot.

The bridges described in the Paper were designed by the Author, who also supervised their construction.

The Paper is accompanied by four sheets of drawings, from which the *Figs.* in the text have been prepared.

[APPENDIX.

10. Attachments - A Brady, A.B. "Low Level Bridges in Queensland", ICE minutes of Proceedings 124 (1896):Paper 2880 pp323-326.

APPENDIX.

Cost of the Materials used in the Construction of the Four Bridges described in the Paper.

Herbert River Bridge.

	£	s.	d.	
Excavation for foundations of piers and abutments	1	5	0	per cubic yard.
Portland cement concrete (6, 3 and 1)	3	5	0	,, ,, ,,
Steel-trough superstructure	24	0	0	,, ton.
Wrought-iron in bolts, &c.			4	,, lb.
Sawn or squared timber		4	0	,, cubic foot.
Tarred metalling on decking		11	0	,, ,, yard.

Balonne River Bridge.

	£	s.	d.	
Bloodwood piles, 17 inches diameter		3	6	,, lineal foot.
Round timber in girders and corbels 17 inches diameter		4	9	,, ,, ,,
Sawn or squared timber		4	9	,, cubic ,,
Wrought timber in handrails, &c.		6	6	,, ,, ,,
Wrought-iron in bolts, &c.			7	,, lb.

Mary River Bridge, Tiaro.

	£	s.	d.	
Ironbark piles, 18 inches diameter		4	3	,, lineal foot.
,, ,, 17 ,, ,,		4	0	,, ,, ,,
Sawn or squared timber		4	0	,, cubic ,,
Round timber in girders and corbels, 17 inches diameter		4	3	,, lineal ,,
Wrought timber in handrails, &c.		7	0	,, cubic ,,
Wrought-iron in bolts, &c.			4	,, lb.
Excavation to rock for pier foundations		10	0	,, cubic yard.
Sinking holes in rock for lewis-bolts	1	0	0	each.
Portland cement concrete in foundation	2	10	0	per cubic yard.

Mary River Bridge, Gympie.

	£	s.	d.	
Ironbark piles 16, 17 and 18 inches diameter		3	1	,, lineal foot.
Round timber in girders and corbels, 16, 17, and 18 inches diameter		3	0	,, ,, ,,
Sawn or squared timber		2	10	,, cubic ,,
Wrought timber in handrails, &c.		3	2	,, ,, ,,
Wrought-iron in bolts, &c.			5	,, lb.

ENGINEERS
AUSTRALIA
Queensland Division

Engineering House
447 Upper Edward Street
Brisbane Qld 4000

PO Box 864
Spring Hill Qld 4004

Telephone 07 3832 3749
Facsimile 07 3832 2101
Email qld@engineersaustralia.org.au
Web qld.engineersaustralia.org.au

ABN: 63 020 415 510

4 June 2013

Ms Leanne Marsh
CEO
Hinchinbrook Regional Council
PO Box 366
Ingham QLD 4850

Dear Ms Marsh

Gairloch Bridge over Herbert River – HERITAGE RECOGNITION PROPOSAL

Engineers Australia Queensland Division proposes to nominate the Gairloch Bridge over the Herbert River for recognition by Engineers Australia Heritage Recognition Committee. The Engineers Australia (EA) website at http://www.engineersaustralia.org.au/heritageregister/search sets out procedures for this program, which aims to bring public recognition to outstanding examples of engineering heritage and to the engineers who created them. *A copy of a proposal to nominate outlining initial information is attached for your information.*

It is recognized that the Gairloch Bridge has been placed on the Heritage Register with the Department of Environment and Heritage Protection.

Heritage recognition would not affect the operation or functions of the bridge. It will be celebrated in a heritage recognition ceremony and on site identification with a marker and interpretation panel highlighting its engineering significance. Engineers Australia provides the heritage marker and interpretation panel with the owners bearing the cost of mounting the marker and panel. The modest function costs of the heritage recognition ceremony are usually shared between the owner and Engineers Australia. No restrictions to the site are involved in the program, and the only legacy long term is for the site owners to care for and maintain the marker and interpretation panel.

The Brisbane based Heritage Panel of Engineers Australia (EHAQ) will organise the nomination and the ceremony with the assistance of representatives from the council. In recent years Her Excellency the Governor of Queensland, Ms Penelope Wensley, has regularly attended EHAQ heritage recognition ceremonies on site.

Recent examples of previous heritage recognition ceremonies in Queensland are on the EA web site http://www.engineersaustralia.org.au/queensland-division/welcome-queensland-branch-webpage.

Since 1984, a total of 15 sites have been recognised with Engineering Heritage Plaques/Markers in Queensland, and over 150 throughout Australia.

Engineers Australia conducts this program only with the approval and support of the owners and operators. Accordingly EA seeks the Councils formal approval and support to proceed with this important recognition, and to join EA in the project. Should Council agree it is planned to formally lodge a nomination for approval by early 2014 with a recognition ceremony planned for May 2014.

If you require further information regarding this proposal, please do not hesitate to contact me.

Yours faithfully

per Andrew Barnes
Chair
Engineering Heritage Australia – Queensland

c.c. Mr Colin Gray – Engineering Services Engineer

Attachments (1) Proposal to Nominate for a Heritage Recognition Award

Engineers Australia

Proposal to Nominate for a Heritage Recognition Award

Gairloch Bridge

Herbert River, North Queensland

1. Introduction

The Gairloch Bridge across the Herbert River near Ingham, North Queensland was constructed in 1890 – 1891. It became an important link for the cane industry as the first bridge across the wide Herbert River providing access to the regions port for growers on the north side of the river. The bridge is currently the responsibility of the Hinchinbrook Shire Council and is still operational with a load limit. The bridge has also been recognized by the Queensland Heritage Register.

2. Historical Significance

As an early, experimental submersible bridge, The Gairloch Bridge is important in demonstrating the evolution of bridge design in Queensland and exemplifies how the colonial authorities responsible for bridge building responded to the extreme conditions of the north Queensland wet season. Submersible bridges evolved as a cost-effective solution to the problem of bridging rivers that were seasonally subject to extreme flooding, and remain common in Queensland.

Gairloch Bridge 1900

The bridge also demonstrates the evolution of the use of concrete in bridge construction in Queensland. The Gairloch Bridge is an example of the earliest use of concrete where it was restricted to applications requiring only compressive strength such as piers and abutments. It was also used in the construction of the deck where it was placed on top of the steel trough decking. The Gairloch bridge is important in demonstrating the principal characteristics of submersible bridges: it is a low level bridge crossing only the main channel and is designed to present the least possible obstruction to flood waters and debris

3. Bridge Designer

The Gairloch Bridge was the first road bridge designed by Alfred Barton Brady as Engineer for Bridges in the department of Mines and Works. Other bridges designed by him include the Burnett River Bridge at Bundaberg, Old Victoria Bridge in Brisbane (no longer exists) and the Lamington Bridge in Maryborough. Brady had a distinguished career rising to the position of Government Architect and Engineer of Bridges in 1892 and Undersecretary in 1901 until his retirement in 1922.

4. Summary
   - The Gairloch Bridge represents a significant development in the design of bridges serving north Queensland being built in 1890 – 91.
   - For its time it was innovative in design with the use of steel trough decking enabling it to be submersed during flood times.
   - It was one of the earliest bridges in Queensland to use concrete in its construction Previous bridges were of timber substructures.
   - The bridge designer Alfred Barton Brady went on to design a number of other well known bridges in Queensland.

5. References

   a. Queensland Heritage Register - Gairloch Bridge
      Department of Environment and Heritage.

   b. Hinchinbrook Shire Council
      Condition and Structural Assessments Bridges
      Gairloch Bridge, Gairloch Road, Ingham
      GHD Aug 2010

   c. Hinchinbrook Shire Council
      Gairloch Bridge
      Decommisioning Plan
      GHD Aug 2010

   d. Guide to Engineering Heritage Recognition Program
      Engineers Australia.

HINCHINBROOK
SHIRE COUNCIL

29 JUL 2013

ENGINEERING SERVICES

25 Lannercost St
Ingham QLD 4850

Telephone: (07) 4776 4605
Facsimile: (07) 4776 3233

Your Ref:
Our Ref: BEL:RLS File No.079/0016
O:\Technical Services\Engineering\Letters\Letter_Gairloch Bridge_Heritage Recognition_25.07.13.doc
Enquiries: *Mr Bruce Leach* ☎ *(07) 4776 4605*

25 July 2013

Mr Andrew Barnes
Chair - Engineering Heritage Australia – Queensland
PO Box 864
SPRING HILL QLD 4004

CC: Allan Churchward
Engineers Australia Heritage Panel
Email: alcynth@ozemail.com.au

Dear Mr Barnes

RE: GAIRLOCH BRIDGE OVER HERBERT RIVER – HERITAGE RECOGNITION PROPOSAL

I refer to your correspondence dated 4 June 2013 in regards to the Gairloch Bridge Heritage Recognition Proposal.

A report was presented to Council on 16 July 2013 where it was resolved that Council agree to the nomination of the Gairloch Bridge for recognition by the Engineers Australia Heritage Recognition Committee in the terms presented to Council.

Council thanks your Committee for its interest in the Gairloch Bridge and looks forward to our continuing association

Should you require any further information or clarification, please contact Council's Manager Engineering Services, Mr Bruce Leach, on ☎ 4776 4605.

Yours sincerely

L E Mash
CHIEF EXECUTIVE OFFICER

Per
B E Leach
MANAGER ENGINEERING SERVICES